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ABSTRACT

The Macintosh microcomputer was selected by Drexel University as part of a program that requires all freshman to have access to a personal computer. Because of a lack of good courseware for the chosen microcomputer, especially in electrical engineering, Drexel has provided faculty release time, several development systems, computer assisted instruction (CAI) workshops, and some support personnel. The faculty in the Electrical and Computer Engineering Department are preparing CAI programs for the sophomore courses in Introduction to Computer Logic, and Circuits and Systems. Two approaches to CAI programs are being used that vary in how users proceed through the material. Both approaches are interactive dialog methods that run well on the Macintosh system. In one method, introductory material and theory are followed by examples and problems. Students can select the topics and sub-topics in a unit that they wish to study by using the program menu. In the second approach, students' progress depends on their responses to a series of problems. Remediation is offered in each case of an incorrect response. (LMM)

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COMPUTER-AIDED INSTRUCTION IN CIRCUIT ANALYSIS FOR THE PERSONAL COMPUTER

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COMPUTER-AIDED INSTRUCTION IN CIRCUIT ANALYSIS FOR THE PERSONAL COMPUTER[1]

Background

In the Winter of 1982 W. W. Hagerty, the past President of Drexel University, a mechanical engineer, announced that next year all incoming Freshmen would be required to own a personal computer. The University community had mixed feelings. Some thought it would be good for the science and engineering students but not the others (design, humanities, business and social sciences). Hagerty's reasoning was that in 1988 when these students graduate from Drexel most would be using a personal computer anyway. This way they would have use of the computer during their time as a student in a computer oriented educational environment.

The V.P.A.A., Dr. B. Sagik formed two university committees; one to specify our requirements for the personal computer and the other committee to define how it would be used at Drexel.[2] I was asked to serve on the second, the Microprocessor Users Committee, which I still serve on. The first group, the Selection Committee, saw or was seen by nearly every computer company in the world. After careful consideration by the Selection Committee and seeing what Apple Corp. had hidden in a "secret room" in Cupertino, CA, they selected a personal computer that was to be later known as the Macintosh.

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[1] Paper published in Proceedings of the 1984 Frontiers in Education Conference, Philadelphia, PA, October 3-5, 1984.

[2] Two reports, "Choosing the Machine" and "Preparing the Faculty", are available from the Microcomputing Program, Drexel University, Phila., PA 19104.

The Macintosh met all the specifications outlined by the Selection Committee. The committee members who were able to see demonstrations of the system reported to us at Drexel of seeing a machine unlike anything we had seen or even heard of before. It was extremely user-friendly, graphics oriented and had a unique input device, later to be known as a "mouse".

The main drawback would be that as a new system there would be no library of software available when the machine was released. Apple promised a major program for developing software for use on the Macintosh and they would cooperate with Drexel to help us develop educational software. Later 24 universities formed a consortium of Apple Macintosh users. Drexel was the only university to require all their freshmen to have access to a personal computer. All but a handful of the 1900 freshmen purchased the Mac when it finally arrived in April of this year

The administration at Drexel realized that the success of the microcomputer program would largely depend on the cooperation and effort put forth by the faculty as a whole. Resources were obtained from the Pew Memorial Trust to support the faculty in the development of software for course applications or other educational related work on the microcomputer project. In addition, the University obtained several eminent people in the field of computer education to hold seminars and workshops on computer-aided instruction for the faculty.

Introduction

We realized very early that there was almost no good courseware available for us to port directly to the Macintosh, especially in electrical engineering. Not many universities had been successful in developing useful software and few had done it for a personal computer. At Carnegie-Mellon, Drexel and RPI, some work had been done in electrical engineering, but for use on large computer systems. (See Ref.1 for an overview and survey of electrical engineering courseware development).

When the Macintosh arrived in April of 1984 there was no public courseware available. The machine came with three application disks; word processing, graphics and a spread sheet. The faculty was not able to develop any courseware to this point as there were no Macintoshs available for faculty use until after the students received theirs. The most used application of the Macintosh during the first year (beginning in April) was in word processing. Many of the Freshmen used it to prepare their term papers in English III.

As of this writing (mid July) the languages available for use on the Mac are Microsoft Basic and a pre-release version of Pascal. Basic is not a good programming language for educational software on the Macintosh. A more structured language such as Pascal is a better choice, and only recently became available for the Mac at Drexel. The only mechanisms for software development at Drexel are several Lisa/Mac cross development systems. Both machines are needed plus a development system provided by Apple to down load onto the Macintosh.

Drexel has provided released time, the several development systems, CAI workshops for faculty and some support personnel. As of now the number of quality support people seems to be too small. A large number of students are employed and many are not properly trained as programmers. In mid-June the University microcomputer development department ran a weeklong seminar on software development techniques for the faculty and new programmers. This training seminar should help improve the quality of those programmers hired to work with the faculty.

Faculty Develops Software

Throughout the University faculty have been working on development of instructional software for use on the Macintosh. The Chemistry Department has been active in writing material for Freshmen chemistry courses. Many in the College of Engineering are now preparing material for use in the second year of the program (1984-85). Several of us in the

Electrical and Computer Engineering Department are preparing materials for our Sophomore year courses. These are: Introduction to Computer Logic, and Circuits and Systems I, II, and III. Table I gives the topics covered in the Computer Logic program. And Table II is a list of topics covered in the Circuits and Systems modules.

Number Systems
Algebraic Manipulation
Karnaugh Maps
Combinational Logic
Sequential Logic
Microcomputer Operation

Table I: Topics in Digital Logic

Circuit Variables
Circuit Elements
Sources, Manipulation and Transformations
Basic Circuit Laws
Circuit Theorems
Power, Ave. and RMS Values
Loop Analysis
Nodal Analysis
Exponential Functions
Singularity Functions
Natural Response of 1st Order Ckts.
Complete Response of 1st Order Ckts.
Natural Response of RLC Ckts.
Sinusoidal Response of RLC Ckts.
Complex Algebra and Phasors
Impedance and Admittance
Frequency Plots/Complex Plane
Bode Plots

Table II: Topics in Circuits and Systems I, II, and III

As mentioned earlier there is little electrical engineering materials available and none of it is written for the Macintosh computer. So we decided to start from ground zero.

We based our approach on the principles described by A. Arons (2) and A. Bork (3) on preparing effective computer-aided instructional material. That is,

- minimize textual material
- present small segments per screen
- use of Socratic dialog
- understand the reasoning process of the dialog
- logically structure the subject matter
- anticipate all possible student responses
- use self-paced programs
- stress the uses of graphics
- evaluate and improve material
- work in groups (2-4) to review, rewrite and criticize material

Instructional Approaches

Our basic philosophy in using the CAI material for the above listed courses is to provide our electrical engineering students with complementary material in each course. That is, very little new material will be covered on the computer. The CAI modules will review, expand and explain the practical aspects of the course work. Emphasis will always be placed on the practical parts of the course; that is, problem solving.

The literature on learning with computers gives no best way of learning with the computer. The method of interactive dialog appears to be one method that could be successful. See reference 4 for a discussion of computers in education and the computer as a teacher.

Having no previous experience in developing computer-aided

instructional material we decided to try two similar approaches. Each is an interactive dialog method which runs well on the Macintosh system. The "dialog boxes", "windows" and "mouse input" that are available on the Mac provide a simple and direct technique for an interactive dialog program.

The basic difference between the two approaches is how the user, the student, gets into the material. In one method some introductory material and theory is presented first followed by examples and then problems. The student selects the topic he/she wishes to study by "clicking" the topic under the Module list and then selects the sub-topic under the Units list on the Mac menu bar. When the student finishes the last problem of the unit he or she can go on to the next unit or select another module.

Figure 1 shows an example of the Units menu display under the module Sources. The program is written so that the user may continue to the next screen in the program, repeat the same screen (this is needed when an incorrect response is given), or go back to the Unit menu list. Every screen in the program will provide this choice, see Fig. 2. Screens that ask questions and require the user to respond will contain an additional "response box" as shown in Fig. 3. All user inputs will be provided via the mouse by clicking it at the appropriate screen location. Later we plan to have the user respond to questions by clicking circuit-element locations on other screen positions as in a Truth Table.

Figure 4 shows the use of the "answer box". Every screen that requires the user to answer a question will generate a response via an answer box as shown here.

In the second approach we present the student with a simple problem as the first screen when the unit is selected. If the student is able to do the problem correctly another problem is generated. However, if the response is not correct the next screen will be a tutor screen containing material that should help the student learn the material that he or she appears not to know. Several wrong responses will be possible and each will generate an appropriate screen to teach the material needed. In general most students should be able to click through the first few problems correctly in each unit. The last few problems should require help for most students.

These two approaches will be tested and evaluated during the first several months of our computer-aided instruction project in electrical engineering. We hope to be able to report our results in the near future.

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